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Open reduction and internal fixation of isolated 4th metacarpal shaft fracture in recreation athletes: single center results

Otvorena redukcija i unutarnja fiksacija prijeloma 4. izolirane metakarpalne kosti kod rekreacijskog sportaša: rezultati iz jednog centra

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Summary

Background: Metacarpal fractures are common injuries, which appear in the general population, as well as in the population of athletes.

Aim: The aim of this retrospective study was to show a twofold series of isolated 4th metacarpal shaft fractures exclusively in the population of recreation athletes, which were surgically treated and the time frame of their return to everyday activities according to applied measures of treatment and postoperative care.

Study design: Retrospective observational study.

Methods: A retrospective single center study was conducted, including 49 patients (37 male, 12 female), mean age 25.7, with isolated 4th metacarpal shaft fracture, which occurred during the two-year period from January 2010 to December 2011. Inclusion criteria were: isolated dislocated 4th metacarpal shaft fracture, acute injury with onset no longer than 10 days before being admitted to hospital, recreation athletes and participants younger than 40 years of age. Injury mechanisms were direct contact or punch (26), fall (14) and rotational motion of the hand (9). Patients were surgically treated with internal fixation with low profile plates (20) or with 2 or 3 (29) mini-screws. Patients followed protocol for one-day surgery and afterwards standard rehabilitation protocol with early mobilization.

Results: The mean follow-up of the patients was 12 months. Average total value of postoperative MCP flexion was 54.7 degrees and MCP extension was 8.97 degrees and total value of postrehabilitational MCP flexion was 88.97 degrees and MCP extension 17.04 degrees. No complications were noted, all fractures healed, without any signs of infection or malunion.

Conclusion: Surgical treatment of the 4th metacarpal shaft fracture with low profile plates and mini-screws is a good technique that represents rigid fixation and provides fast recovery to pre-injury range of movements. The quality of life is enhanced due to fast recovery and return to normal daily and sports activities. Such treatment indicates profitability, hence to a one-day surgery, decreasing treatment costs and resulting in high beneficial aspects for patients.

Key words: 4th metacarpal shaft, fracture, recreation athletes, early return

Sažetak

Pozadina: Prijelomi metakarpala uobičajene su povrede koje se pojavljuju kod opće populacije, kao i kod sportaša.

Cilj: Cilj ove retrospektivne studije je prikaz dvostruke serije prijeloma 4. izolirane metakarpalne kosti kod rekreativnih sportaša podvrgnutih kirurškom zahvatu i njihovom razdoblju oporavka primjenjujući mjere liječenja i postoperativnu njegu do povrata njihovim svakodnevnim aktivnostima.

Plan studije: retrospektivna studija promatranja.

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Metode: Obavljena je jedna retrospektivna studija koja je uključila 49 bolesnika (37 muškaraca, 12 žena) prosječne dobi od 25,7 s izoliranim prijelomom 4. izolirane metakarpalne kosti koji se dogodio u dvogodišnjem razdoblju od siječnja 2010. do prosinca 2011. Kriteriji su: dislocirani prijelom 4. izolirane metakarpalne kosti, akutna ozljeda koja je nastupila ne dulje od 10 dana prije prijema u bolnici kod rekreativnih sportaša i učenika mlađih od 40 godina. Mehanizmi povreda bili su izravan kontakt ili udarac šakom (26), pad (14) i rotacijski pokret rukom (9). Obavljen je kirurški zahvat s unutarnjom fiksacijom pomoću pločica niskoga profila (20) ili 2 do 3 mini-vijka. Bolesnici su obavili protokol za jednodnevni kirurški zahvat, nakon čega je slijedila standardna rehabilitacija i rana mobilizacija.

Rezultati: Prosječno praćenje bolesnika bilo je 12 mjeseci. Prosječna sveukupna vrijednost MSC fleksije bila je 54,7 stupnjeva te MCO ekstenzije 8,97 stupnjeva, a sveukupna vrijednost postrehabilitacijske MCP fleksije 88,97 stupnjeva i MCP ekstenzije 17,04 stupnjeva. Nisu primijećene nikakve komplikacije, svi su se prijelomi zaliječili bez znakova infekcije ili krivoga srastanja kostiju.

Zaključak: Kirurško liječenje prijeloma 4. izolirane metakarpalne kosti s pločicama niskog profila i mini-vijcima je dobra tehnika koja predstavlja čvrstu fiksaciju i osigurava brzi oporavak do pokreta prije povreda. Povećava se kvaliteta življenje uslijed brzog oporavka i povrata normalnim dnevnim i sportskim aktivnostima. Takvo liječenje znači profitabilnost s jednodnevnim operativnim zahvatom, smanjujući troškove liječenja s rezultatima od velike koristi za pacijente.

Ključne riječi: 4. metakarpalna kost, prijelom, rekreacijski sportaši, rani povrat.

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Introduction

Metacarpal fractures are common injuries that appear in the general population and make up to one third of all hand fractures and about one fifth of all fractures which are located under the elbow level.[1, 2, 3] In athletes, isolated metacarpal fractures and combined with phalangeal fractures make up from one quarter to one third of all body fractures.[4, 5, 6]

Most frequent mechanism of metacarpal fracture injury in athletes is a fall on the hand which is fully stretched or direct blows during contact with a ball, helmet or another player.[5, 7]According to the type of sport, metacarpal fractures occur most frequently in wrestling, football, basketball and hockey. Characteristics, incidence and location of the metacarpal fractures are directly correlated with the category of sport that the athlete is competing in.[7, 8]

Due to anatomical preferences, most often fractures of metacarpal bones occur on the neck of the 5th finger and on the shaft of the 4th finger.[9] In the past, most of these fractures were treated conservatively with bracing that enabled protection and as quick as possible return to play which is the highest priority in the life of an athlete.[6, 10] Indications for operative treatment of fractures are slightly different in the athlete population, compared to general population, since it is necessary to provide prompt and adequate function, which enables early return to training activities,[11] and, at the same time, does not compromise the healing of fracture and process of recovery.[7]

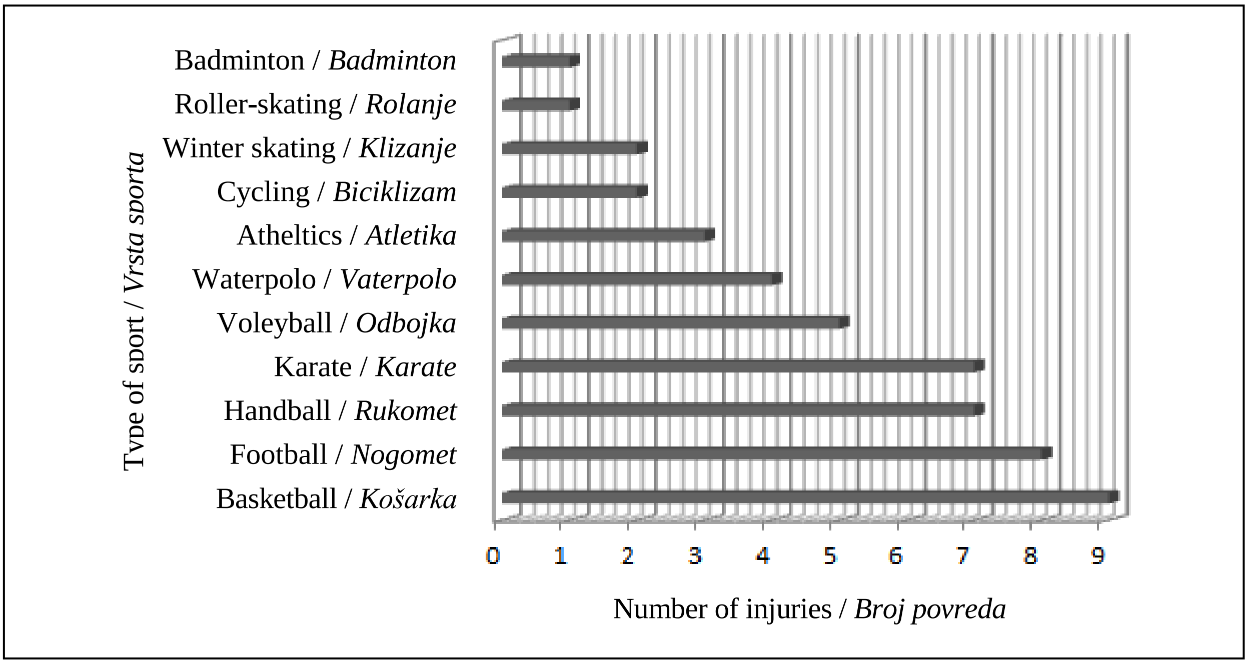
The aim of this study is to present a group of patients, all recreation athletes, with isolated 4th metacarpal shaft fractures which were surgically treated. Moreover, we represent the time frame of return to everyday activities according to the type of treatment and postoperative care. The represented results could be the base for future investigations and supplement for body knowledge in the treatment of isolated 4th metacarpal shaft fractures in the population of recreation athletes.

Materials and methods

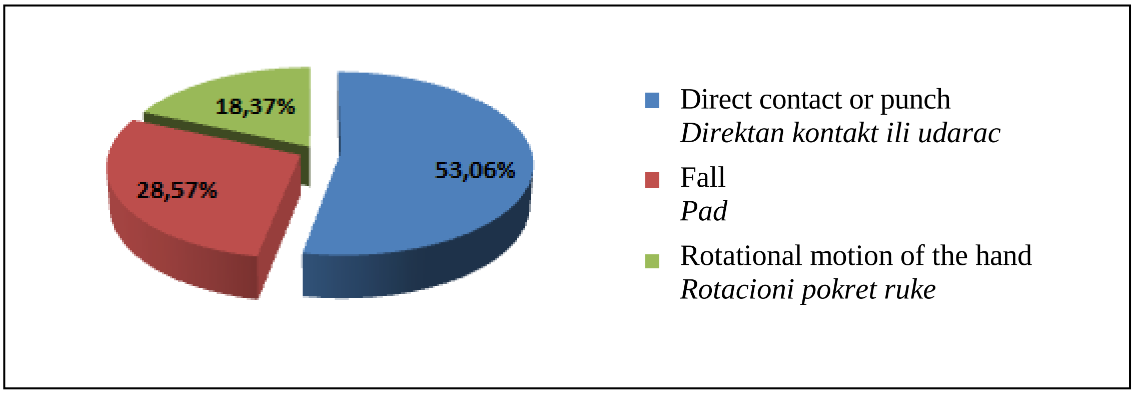
A retrospective single center study was performed. The Ethics Committee approval was received for this study. 49 patients with isolated 4th metacarpal shaft fracture (37 male, 12 female), mean age 25.7 (age range 15-40), were surgically treated during the time period of two-years (2010 to 2011). A single surgeon performed all the operative procedures. Inclusion criteria were: isolated fracture of the 4th metacarpal shaft, acute injury with onset no longer than 10 days before being admitted to hospital, recreation athletes and participants younger than 40 years of age.

The categories of sports of the participants were as follows: basketball (9 cases), football (8 cases), handball (7 cases), karate (7 cases), volleyball (5 cases), waterpolo (4 cases), and athletics (3 cases), cycling (2 cases), winter skating (2 cases), roller-skating (1 case) and badminton (1 case), as depicted in Picture 1.

There were three different types of injury mechanism, and they included direct contact or punch (26 cases, fall (14 cases) and rotational motion of the hand (9 cases), as depicted in Picture 2.



Picture 1 Number of injuries gained considering type of sport.
Slika 1. Broj povreda prema vrsti sporta



Picture 2 Structure of injury mechanism
Slika 2. Struktura mehanizma povreda

The evaluation of all gathered information was analyzed with regular software program Microsoft Excel, which is a part of the Microsoft Office pack 2010, Microsoft, Redmond, Washington, USA.

All patients presented with tenderness and lump over the region of 4th metacarpal bone were examined. The neurovascular status, range of motions, deformity of the affected bone, shortening of the finger, finger cascade and soft-tissue damage were examined. Possible rotational deformity was observed during the patients' performing action of metacarpophalangeal (MCP) flexion and extension. MCP flexion and extension were compared to normal MCP flexion of 90 degrees and MCP extension between 10 and 30 degrees. Standard X-ray in two planes, anteroposterior and lateral view, were performed and sometimes were followed by an oblique view for additional information. Possible shortening, angulation and rotational deformity were detected. The diagnosis of acute 4th metacarpal shaft fracture was set based on clinical and radiographic examination.

Surgical procedure

All the surgical procedures (open reduction and internal fixation) of the fracture were performed under regional anesthesia (axillar or supraclavicular block).

The fracture was treated through a midline dorsal incision in the projection of fractured 4th metacarpal bone, avoiding damage of the extensor tendon. The incision of the juncturae tendinea was performed, and the fracture site was located. Open reduction of fractured fragments was performed with the usage of a reduction clamp. The type of implanted osteosynthetic material depended on the type of fracture (transverse, oblique, spiral or comminuted). The internal fixation was performed with the usage of low profile plates (20 cases) for transverse and comminuted fractures (Picture 3. a, b), while fixation with usage of 2 mini-screws (23 cases) or 3 mini-screws (6 cases) was performed for oblique and spiral fractures (Picture 4. a, b), as depicted in Table 1.

Table 1 Structure of applied surgical procedure for internal fixation.

Tablica 1. Struktura primjenjenog operativnog postupka za unutarnju fiksaciju

Applied type of internal fixation *Primijenjena vrsta unutarnje fiksacije*	Number of cases *Broj slučajeva*	Structure *Struktura*
Low profile plates *Pločice niskog profila*	20	40.82%
Fixation with 2 mini screws *Fiksacija s 2 mini vijaka*	23	46.94%
Fixation with 3 mini screws *Fiksacija s 3 mini vijaka*	6	12.24%
Total *Sveukupno*	49	100.00%

The adequate position of the osteosynthetic material was confirmed with intraoperative radiographic imaging in two planes, anteroposterior and laterolateral view. The operative incision was closed typically, including dissected juncturae tendinea.

Picture 3 a, b Anteroposterior (a) and laterolateral (b) view of radiographic imaging of patient with transverse 4th metacarpal shaft fracture after open reduction and internal fixation with low profile plate.

Slika 3.a i 3.b Anteroposteriorni (a) i laterolateralni (b) pregled radiografske slike pacijenta s poprečnim prijelomom 4. metakarpalne kosti s otvorenom redukcijom i unutarnjom fiksacijom s pločicom niskog profila

Picture 4 a, b. Anteroposterior (a) and laterolateral (b) view of radiographic imaging of patient with oblique 4th metacarpal shaft fracture after open reduction and internal fixation with 2 lag screws.

Slika 4.a i 4.b Anteroposteriorni (a) i laterolateralni (b) pregled radiografske slike pacijenta s kosim prijelomom 4. metakarpalne kosti s otvorenom redukcijom i unutarnjom fiksacijom s 2 lag vijka

Postoperative management

According to previously published studies about early post-operative treatment[12,13,14] all patients followed standard rehabilitation protocol with early mobilization, to prevent tendon adhesion and stiffness. The mentioned treatment protocol was applied since plates or screws provided sufficient stability and therefore allowing and stimulating early motion. Patients were discharged from hospital on the day of surgery, and returned for regular ambulatory outpatient controls. Sutures were removed between 8 and 10 days after the surgery (average time 9.1 day). After the sutures were removed, active motions with increasing range were allowed. Every patient underwent physical therapy immediately after the wound healing, which was performed ambulatory at the Department for Physiotherapy in the time period of 2 weeks. Final outcomes were detected.

Results

The surgical procedures were performed between 2 and 10 days following the onset of fracture (average time 4.9 days) depending on the patients' appearance in the Department of Surgery. Patients were discharged from hospital on the same day the surgery procedure was performed, and were recommended for outpatients' protocol. All patients underwent ambulatory physical therapy for a period of two weeks, and it started after the sutures were removed.

The mean follow-up of the patients was 12 months. Clinical status was observed by a range of MCP extension and flexion postoperatively and after completing physical therapy measures. Improved range of motions was detected in every patient. The average total value of postoperative MCP flexion was 54.7 degrees and MCP extension was 8.97 degrees.

After completed physical therapy, the range of motions changed immensely, and the average value of MCP flexion was 88.97, compared to normal MCP flexion of 90 degrees and average MCP extension was 17.04 degrees, compared to normal MCP extension of 10 to 30 degrees. No complications were noted, all fractures healed, without any signs of infection or malunion. Finally, at the final outpatient examination, no deformities were detected, neither rotational deformities nor angulation.

Discussion

The indication for conservative or surgical treatment depends on various factors. A standard decision is made according to the stability of the fracture type. Unstable fractures are those with rotational deformity, which is generally not tolerable, since each degree of rotational deformity in metacarpals affects to roughly about 5 degrees of rotational deformity in the fingers. Angulations in the 4th finger can be tolerated up to 10 to 15 degrees, due to the ability of the last two carpometacarpal joints to flex up to 20 to 30 degrees. However, angulation in 2nd and 3rd finger is not tolerated at all, since its carpometacarpal joints are without any motion. Also, shortening larger than 2 to 3 mm, participation more than one quarter of articular surface and step off in the area of articular surface bigger than 1 mm are absolute indications for surgical treatment.[12,15]

Moreover, we must, take into account not only the pattern of the fracture, but also other parameters, such as involvement of the dominant hand, the patient's profession, mechanism and time of the injury, former injuries and former surgical treatments in the location of the affected hand.[15]

In cases in which there are no signs of displacement of the fracture fragments and where the patients' compliance is satisfactory, metacarpal fractures can be treated conservatively with closed reduction and splinting. Usually a 3 to 4-week period of splinting is enough to achieve adequate healing for the start of the early motions. Radiographically healing with callus can be noted after a 4 to 6-week period.[12]

Interfragmentary screws are applied in long oblique fractures, and, depending on the longitude, two or three screws can be applied. Lag screws are a better method for rigid fixation than K wires.[16] Due to the rigidity that they provide, earlier mobilization is allowed and the risk of postoperative stiffness is minimized. However, the procedure of applying screws is technically more challenging, since it leaves a surgeon with only one chance to succeed in a fixation.[12]

Plate fixation either with stainless steel or titanium plates is a method of choice for rigid fixation of metacarpal bones, which enables early motion.[12] It is successfully applied in transverse or short oblique and comminuted fractures. However, the procedure that is technically challenging implies larger incision, soft-tissue damage, possible lesion of the extensor tendons, later causing possible extensor lag or plate protrusion, development of infection and contracture.[17,18] Although plates provide greater stability compared to K wires or interfragmentar screws, fixation with plates is also related with higher prevalence of complications, in some studies even up to 35%.[18,19]

Intramedullary fixation is also a method in which one bigger wire in the center of the metacarpal bone or a few smaller wires are inserted through a little incision and hidden under the skin. The method does not provide adequate rigidity for early mobilization, so splinting is necessary for a period of a couple of weeks.[12]

External fixation is a good method, especially indicated in open metacarpal shaft fractures and in fractures with partial bone loss. There is no need for larger incisions, and, since the configuration of the fixator is stable, it provides early mobilization of the fingers.[20,21,22] However, there is a possibility for pin-site infection, development of osteomyelitis, re-fracture through the position of the pins, lesion of extensor tendons. Also, such a method is connected with decreased patient compliance.[23]

Another method for surgical treatment of metacarpal fractures is the usage of bioabsorbable plates, which could have the same degree of stability as titanium plates, but until today there is a lack of appropriate scientific information for proper application purposes. Due to this, future investigations must be conducted.[24]

The represented study describes the results of surgical treatment of 4th metacarpal shaft fractures in the population of recreation athletes. Patients were treated with the surgical technique of open reduction and internal fixation, either with low profile titanium plates or lag screws. Both methods are a type of rigid fixation that allow early motion and prevent postoperative adhesions and stiffness. The applied surgical methods do not require the removal of osteosynthetic material, since titanium is inert material. Also, titanium material is safe enough and does not cause any complications in additional radiographic imaging for the purposes of outpatient ambulatory examinations. No complications were noted. All patients were satisfied with the outcome, due to their fast recovery. Both subjective and objective parameters were satisfying.

Conclusion

49 patients, all recreation athletes, suffered from 4th metacarpal shaft fracture and were surgically treated with open reduction and internal fixation. After the procedure, all patients were able to start immediately with early motions, and were discharged from hospital on the day of the surgery. After the removal of the sutures, physical therapy started for a period of two weeks and the patients were able to return to normal daily activities without any complications. The described surgical treatment provides fast recovery to pre-injury range of movements, avoids stiffness and enables satisfying grip strength of the affected hand. All patients had fast recovery and return to normal daily activities, as well as sports activities. This is also an example of a one-day surgery, where the costs of treatment and beneficial aspects for the patient are significantly better than in cases of conservative treatment, and especially in cases in which another additional surgery for hardware removal is necessary. The described surgical treatment is on the whole more profitable compared to others.

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